Laboratory Evaluation of Amalgam Separators

ADA Laboratories

Introduction

- POTW effluent limits for Hg
- Binational Toxics Strategy
- EPA Virtual Elimination
- Discharge into the environment
- Dental office wastewater

Introduction

- Environmental impact ?
- Hg Amalgam
- Identifiable source
- Source reduction
- Amalgam separators

Aim

- **Evaluate amalgam removal efficiency**
- **Determine mercury concentration in effluent**

Amalgam Separators Tested

A1000

Amalgam Collector

Asdex

BullfroHg

Durr 7800

ECO II

Hg 5

Hg 10

MRU

MSS 2000

Rasch 890-4000

RME 2000

Removal Technologies

- Sedimentation
- Filtration
- Chemical Removal
- Centrifugation
- Combinations

ISO Protocol: Amalgam Removal Efficiency

ISO Standard 11143

10 g amalgam with size distribution:

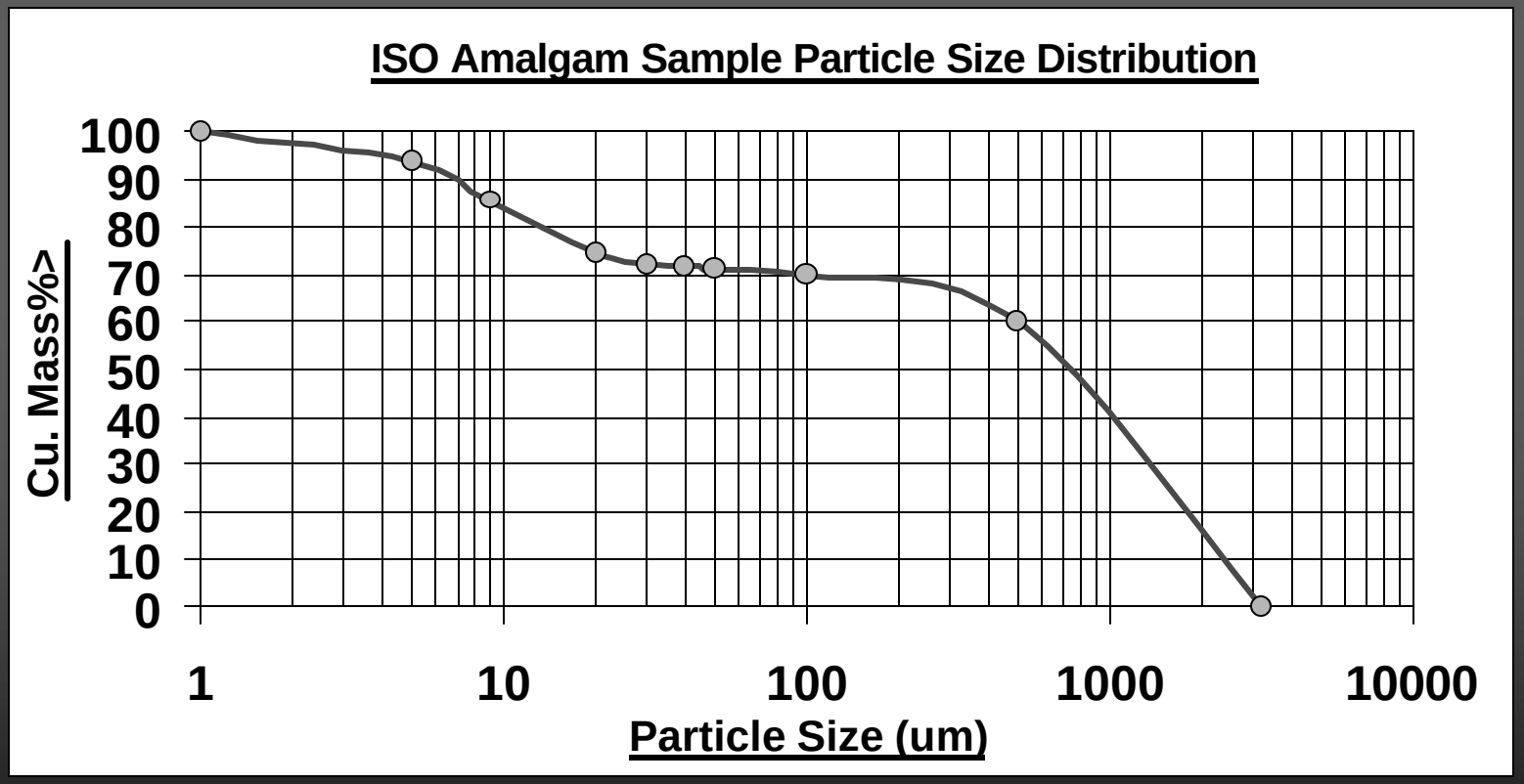
60% ≤ 3.15 mm > 0.5 mm

10% ≤ 0.5 mm > 0.1 mm

30% ≤ 0.1 mm*

*** meets distribution curve**

ISO Protocol: Amalgam Removal Efficiency



ISO Protocol: Amalgam Removal Efficiency

- 1L filtered water
- 1g sodium pyrophosphate
- Slurry + filtered water to achieve maximum flow rate
- Collect effluent

ISO Protocol: Amalgam Removal Efficiency

- Collect amalgam in effluent using pre-weighed filters (12 µm, 3 µm, 1.2 µm)
- Dry filters with collected amalgam to constant weight

Removal Efficiency (E)

$$E\ (\%) = 100\ (W_I - W_F)/W_I$$

W_I = Wt. of amalgam sample

W_F = Wt. of amalgam in filters

Removal Efficiency (E)

- **Amalgam separators tested "Empty" & "Full"**

  except for Hg 10
- **Full = 70% glass beads (1mm) + 30% amalgam (≤ 0.3mm)**

Removal Efficiency (E)

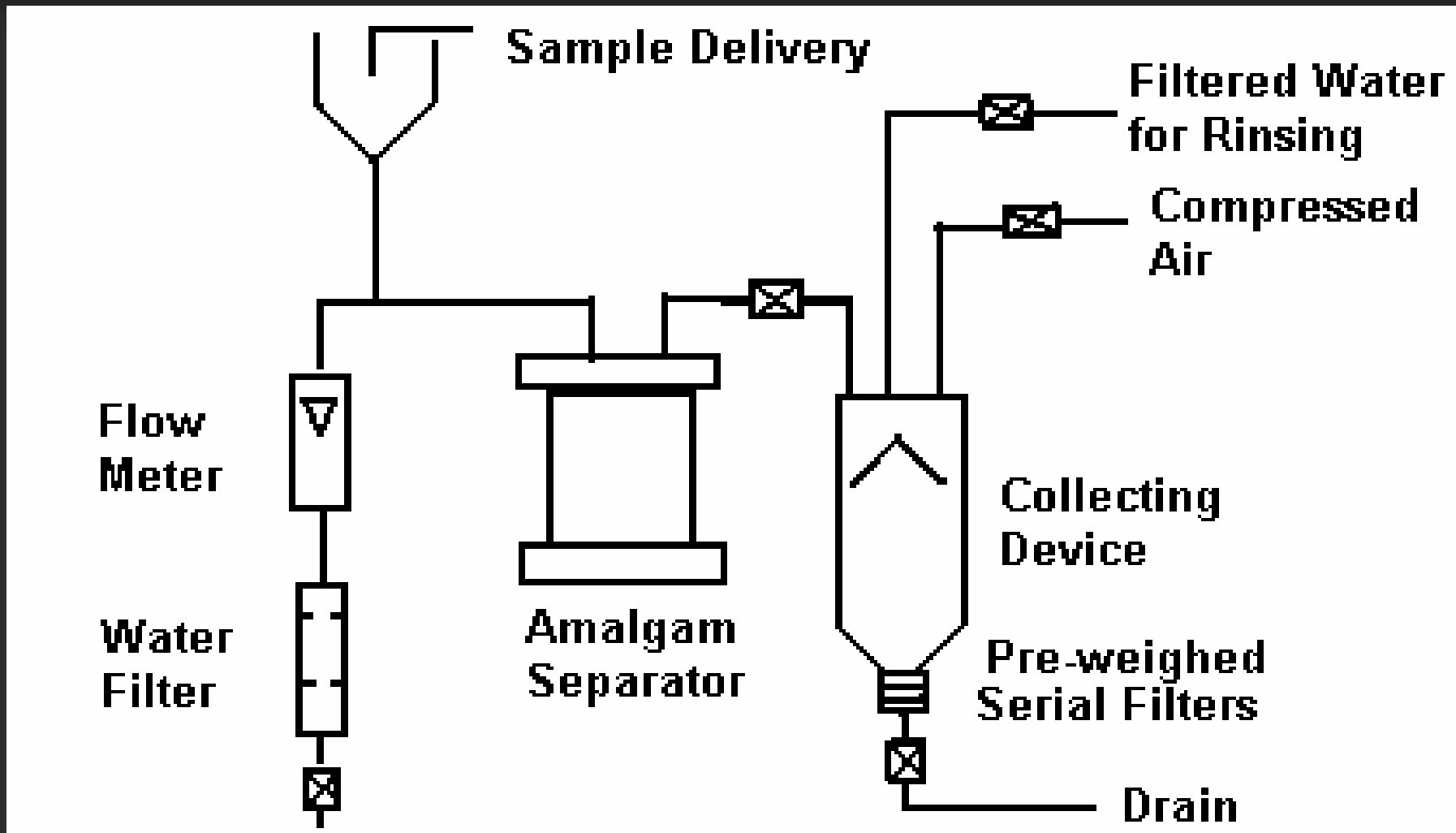
- Tests done in triplicate
- Lower mean value for “Empty” or “Full” is the removal efficiency

Statistical Analysis for Removal Efficiency

- **Among amalgam separators: ANOVA & Multiple Comparison (Tukey)**
- **Each amalgam separator "Empty" & "Full": t-test**

Total Mercury Concentration in Effluent

- Mercury from amalgam in pre-weighed filters (≥ 1.2 µm) by calculation from weight/volume
- Mercury in effluent (< 1.2 µm) by EPA 245.1: acid digestion & AA
- Total = Sum of the above


Sample Delivery
Filtered Water
for Rinsing
Compressed
Air
Flow
Meter
Water
Filter
Amalgam
Separator
Collecting
Device
Pre-weighed
Serial Filters
Drain

Results: Removal Efficiency

ANOVA and Tukey Multiple Comparison showed differences in the amalgam removal efficiencies among the amalgam separators tested using the ISO 11143 protocol

Hg 10	**99.99%**
MRU	**99.95%**
Rasch 890-4000	**99.90%**
Amalgam Collector	**99.89%**
RME 2000	**99.66%**
Hg 5	**99.28%**
Asdex	**99.10%**
MSS 2000	**98.94%**
BullfroHg	**98.88%**
Durr 7800	**97.66%**
ECO II	**97.51%**
A1000	**96.09%**

Removal Efficiency

Except for MSS 2000, for each amalgam separator there are no differences (t-test) between the “Empty” and “Full” amalgam removal efficiencies as measured using the ISO protocol

Total Mercury Concentration in Effluent

Total mercury concentration in the effluent from laboratory testing varied widely for each amalgam separator

Total Mercury Concentration in Test Effluent (ppb)

A1000	**30,200 – 34,899**
Amalgam Collector	**689 – 3,349**
Asdex	**9,474 – 17,953**
BullfroHg	**3,498 – 16,269**
Durr 7800	**967 – 4,045**
ECO II	**16,307 – 39,770**

Total Mercury Concentration in Test Effluent (ppb)

Hg 5	6,429 – 15,150
Hg 10	20 -- 100
MRU	196 – 697
MSS 2000	732 – 6,168
Rasch 890-4000	601 – 1,757
RME	767 – 4,449

Total Mercury Concentration in 55 L of Effluent (ppb)

A1000	**3,283 - 4,671**
Amalgam Collector	**115 - 351**
Asdex	**784 - 8,429**
BullfroHg	**696 - 2,913**
Durr 7800	**887 - 3,615**
ECO II	**1,400 - 2,076**

Total Mercury Concentration in 55 L of Effluent (ppb)

Hg 5	557 - 6,680
Hg 10	9 - 13
MRU	93 - 169
MSS 2000	156 - 1,168
Rasch 890-4000	67 - 157
RME	196 - 629

Conclusions

- **All 12 amalgam separators tested exceeded the ISO 11143 requirement of 95% amalgam removal efficiency**

Conclusions

- **Amalgam effluent from separators in the laboratory test, when chemically digested, had <u>total</u> mercury levels in the ppb range.**

Publications

Laboratory evaluation of amalgam separators.

JADA 2002; 133:577-584.

Amalgam in dental office wastewater.

JADA 2002; 133:585-589.